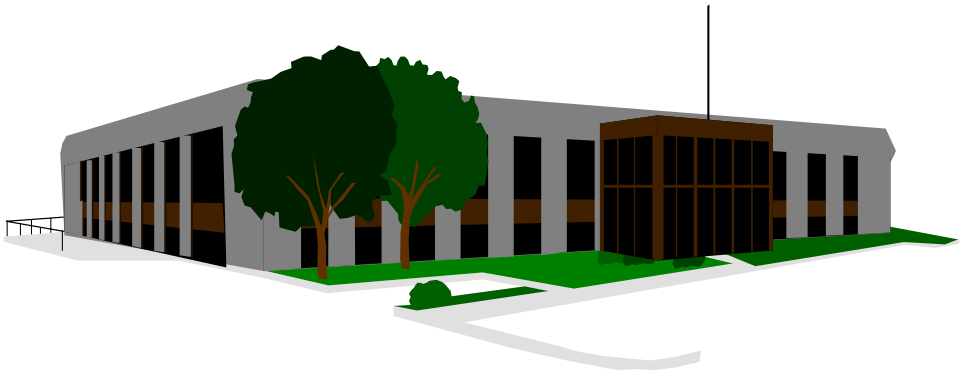
INDOOR AIR QUALITY REASSESSMENT

Central Elementary School
107 Central Street
East Bridgewater, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
May, 2000

Background/Introduction

At the request of Dick Achin, Assistant Superintendent of the East Bridgewater school system, the Bureau of Environmental Health Assessment (BEHA) provided follow-up assistance and consultation regarding indoor air quality issues and health concerns at the Central Elementary School.

On January 13, 2000, a visit was made to this school by Cory Holmes, Environmental Analyst, ER/IAQ and Suzan Donahue, Research Assistant, BEHA to conduct an indoor air quality assessment. Indoor air testing was not done during this visit due to a power outage that had disabled the school's ventilation system. BEHA staff made a visual inspection, accompanied by Lorraine Pratt, Assistant Principal for Central Elementary School. Mr. Holmes returned to the school on February 17, 2000, to conduct a complete IAQ survey of the building. During the February 17th visit Mr. Holmes was accompanied by Larry Witnauer, School Custodian, for portions of the assessment.

Actions on Recommendations

BEHA previously made 26 recommendations **(in bold)** to improve indoor air quality at the school (MDPH, 1999). School officials reported that they have acted on all of these recommendations that are in control of school department personnel. The following is a status report of action(s) on BEHA recommendations based on reports from school officials, documents, photographs and BEHA staff observations.

1. **Discontinue the use of the pottery kiln until an area with proper local exhaust ventilation can be prepared, preferably in an area away from the water heater.**

   The kiln has been disconnected and has not been used since November 12, 1998.

2. **Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Operate univents while classrooms are occupied, repair if needed.**

   All univents were found repaired and functioning by BEHA staff.

3. **Ensure vents remain open in the special services area to provide airflow.**

   Vents in the special services area were found partially closed (see Picture 1). These vents should be checked daily to ensure they are open to facilitate airflow.

4. **Consider relocating art room or providing mechanical ventilation to the existing room.**

   Money has been appropriated to install a mechanical ventilation system for the art room. This project will reportedly begin upon completion of the new roof.

5. **Operate exhaust ventilation during occupancy. Locate exhaust ventilation in cafeteria. Consider restoration of exhaust ventilation in classroom 11.**

   Exhaust vents in classrooms throughout the building were functioning. Exhaust ventilation was installed in room 11 (see Picture 2). Since the vent opening is partially blocked, BEHA staff recommended replacing the vent duct with an alternate configuration that would render the vent opening unobstructed.

6. **Remove all blockages from univents and exhaust vents to ensure adequate airflow. Keep door to classroom 104 shut to avoid blockage of exhaust vent.**

   It was apparent to BEHA staff that occupants have been instructed to remove blockages to univents and exhaust vents, however in a few cases exhaust vents continue to be obstructed in classrooms (see Pictures). More work is needed in this area. Exhaust ventilation for the cafeteria is located behind a large cabinet

(see Picture 3). BEHA staff recommended relocating the cabinet to allow airflow into the exhaust vent.

7. **Once both the fresh air supply and the exhaust ventilation are functioning properly, the ventilation system should be balanced.**

   The East Bridgewater School Department hired an HVAC contractor to balance and maintain the ventilation systems.

8. **Repair any water leaks and replace any remaining water-stained wall and ceiling tiles. Examine the area above and behind these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.**

   A new roof was approved by the town, which should eliminate the water penetration problem at the school. The replacement of water-damaged ceiling tiles is an on-going maintenance project.

9. **Repair broken windows and seal air conditioners properly to avoid drafts and/or water penetration. Observe water-damaged windowsills for mold growth. Disinfect windowsill with an appropriate disinfectant where necessary.**

   Broken windows were repaired/replaced. Window mounted air conditioners are used seasonally and will be installed in the summer. Windowsills will be examined and will reportedly be disinfected as needed.

10. **Remove leaves, pine needles and other debris from gutters. Observe gutter system and downspouts for proper drainage, repair if necessary.**

    School maintenance personnel report that they will examine and clean the school's gutter system periodically to ensure proper drainage.

11. **Examine carpeting in classroom 11 for mold growth and remove if moldy. Disinfect areas of floor underneath water-damaged carpeting with an appropriate antimicrobial.**

    The carpeting in room 11 has been replaced and the floor was disinfected.

12. **Relocate or place tile or rubber matting underneath water cooler in the 210-office area.**

    Plastic sheeting was installed beneath water coolers in carpeted areas to prevent potential water damage.

13. **Move plants and animals away from univents in classrooms. Examine drip pans for mold growth and disinfect with an appropriate antimicrobial where necessary.**

    Plants were removed from the proximity of univents in classrooms.

14. **Consider reducing the number of plants in certain areas.**

    Staff were notified of the plant issue by school administration on November 12 and December 2, 1999 through the school's weekly bulletin.

15. **Replace missing or damaged caulking between countertops and sinks. Observe interior of cabinets for water-damage and mold growth. Disinfect with an appropriate antimicrobial where necessary.**

    Caulking was replaced and cabinet interiors were examined for water damage by school maintenance staff.

16. **Clean and maintain dehumidifiers as per the manufacturer's instructions.**

    Dehumidifiers were cleaned and will reportedly be cleaned regularly by school maintenance personnel. In addition, the dehumidifier in classroom 11 has been modified to empty directly into the sink via a hose (see Picture 4).

17. **Relocate student drop off area or have busses shut off engines after five minutes as required by Massachusetts General Laws 90:16A.**

The Superintendent's office reports that they continue to monitor the situation and are working with the bus company to address this on-going issue.

18. **Store flammable materials in flameproof cabinets consistent with local and state fire codes.**

All flammable materials are located in a storage room equipped with electronic smoke detectors, sprinklers and fire extinguishers approved by the town Building Inspector.

19. **Properly store chemicals and cleaning products.**

Cabinets and storage closets were checked by maintenance staff on February 25 and 26, 1999, for hazardous cleaning products. BEHA staff also recommends that general cleaning products (e.g., glass cleaners, furniture polish, anti-microbials, etc.) be kept out of the reach of students.

20. **Install door to mechanical room adjacent to the special services area. Ensure door complies with local and state fire codes.**

A door was installed in this area to provide a barrier between the mechanical room and the occupied space (see Picture 5). BEHA staff recommended that weather-stripping be installed beneath and around the door to prevent the infiltration of odors into the adjacent space.

21. **Seal utility holes and pipes in mechanical room located in the special services area. Install airtight door for this room to avoid the migration of mechanical room odors into adjacent areas.**

Utility holes were sealed on both sides of the wall between the boiler room and the special services area with foam insulation (see Picture 6). Loose fiberglass insulation was also secured with tape.

22. **Consultation with the Department of Labor and Workforce Development, Division of Occupational Safety, Lead and Asbestos Program and a licensed asbestos abatement contractor would be advisable to determine the likelihood that asbestos is present.**

BEHA staff were provided with asbestos testing reports that were issued December 1985, November 1997 and March 1998. The reports state that no samples were found to contain asbestos fibers (Diversified, 1998).

23. **Acquire current Material Safety Data Sheets for all products that contain hazardous materials and are used within the building, including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL. 1983).**

A completed file of MSDS' is reportedly on file in the school maintenance office (Mr. Murphy's office).

24. **Repair holes in ceilings and walls to prevent egress of odors, fumes and vapors.**

Utility holes were sealed with cement and foam by school maintenance personnel.

25. **Wet traps of drains at least once a week or properly seal abandoned drains to prevent the back up of sewer gas.**

All drains are reportedly checked at least once per week now and filled with water by school maintenance personnel.

26. Provide adequate local exhaust ventilation for lamination machines, photocopiers and mimeographs when used.

The switch to the local exhaust fan has been clearly marked with a sign instructing occupants that the exhaust fan should be in the "on" position when photocopiers are used. This vent also provides general exhaust ventilation for the room. BEHA staff recommended that the sign be modified to read that the fan should be in the "on" position during periods of school occupancy.

In addition to visual assessment of improvements previously recommended, BEHA staff conducted a number of tests as part of the current IAQ assessment.

Methods

Air tests for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with the Mannix, TH Pen PTH8708 Thermo-Hygrometer.

Results

This school has a student population of approximately 800 and a staff of approximately 80. The tests were taken during normal operating hours at the school. Test results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 ppm (parts per million) in fourteen of thirty-six areas surveyed, which is a significant improvement compared to the previous assessment. It is important to note that four of the areas with elevated carbon dioxide levels are not equipped with mechanical ventilation and, in four other areas, univents and/or exhaust vents were deactivated by occupants or partially obstructed (see Tables/Pictures 7-9). Fresh air in most classrooms is supplied by a unit ventilator (univent) system. A univent draws fresh air from a vent on the exterior of the building and air from the classroom (called return air) through a vent in the base of its case (see Figure 1). Fresh air and return air are mixed, filtered, heated and expelled into the classroom through a fresh air diffuser located in the top of the case. As noted in our previous report, univents must remain on and airflow of intakes and diffusers must remain unobstructed in order for univents to function as designed. In addition, staff should ensure that the louvers for the special services area remain open to provide supply and exhaust ventilation.

Exhaust ventilation is provided by a mechanical system. The exhaust system in each classroom consists of ducted, grated wall vents; all classroom exhaust vents were functioning; however a few of these vents appeared to be drawing weakly. In addition, several exhaust vents continued to be obstructed by furniture, shelves and open doors (see previous report). Exhaust ventilation in the special services area was off during the assessment; Mr. Witnauer reactivated the system, which BEHA staff verified.

As noted in our previous report, the Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside

air or have openable windows in each room (BOCA, 1993, SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings were measured between 70^{o} F to 79^{o} F, which was very close to the BEHA recommended range for comfort. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in this building was within a range of 2 to 32 percent, which is below the BEHA recommended comfort range in all areas. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

An active pipe leak was observed beneath the sink in classroom 106. Care should be taken to avoid storage of porous materials (e.g., paper, cardboard, etc.) beneath the cabinet until the leak is repaired. Wetted materials can serve as a mold growth medium, especially if wetted repeatedly.

The January 13th visit occurred on a day of heavy snowfall. Along the perimeter of the building, univent fresh air intakes were noted partially covered with snow (see Picture 10). Care should be taken to ensure that fresh air intakes remain clear of obstructions (e.g., snow, shrubbery, etc.) to avoid the entrainment of dirt, moisture and or pollen.

Other Concerns

Several conditions that can potentially affect indoor air quality were also identified. A number of classrooms had excessive amounts of chalk dust. Chalk dust can be a source of eye and respiratory irritation.

Building occupants had concerns of lingering odors from empty photocopier toner cartridges. Photocopier toners contain volatile organic compounds (VOCs), which can be irritating to the eyes, nose and throat. The exhaust vent for the photocopier room is located on the rear wall opposite the photocopier, which can tend to draw odors across the room toward occupants. In order to avoid odors from empty toner cartridges, BEHA staff recommended the sealing of cartridges in plastic bags or removing them from the building (i.e., disposal of them in the dumpster).

A number of classrooms continued to have cleaning products stored underneath sinks. These items should be stored properly and out of the reach of students.

Conclusions/Recommendations

The actions taken on BEHA's previous recommendations by the East Bridgewater School Department, working in conjunction with the Central Elementary School Health & Safety Committee, have improved overall indoor air quality at the school. In view of the findings at the time of the visit, the following recommendations to those made in the previous report are made to further improve indoor air quality:

1. Continue with activities to improve the building's ventilation system. Have the ventilation engineer examine the exhaust vents in classrooms that appeared to be drawing weakly.
2. Activate and remove all remaining blockages from univents and exhaust vents. Clear snow drifts from univent fresh air intakes during periods of heavy snowfall.
3. Examine the feasibility of replacing the exhaust vent duct in room 11 with an alternate configuration that would render the vent opening unobstructed.

4. Continue with plans to install mechanical exhaust ventilation to the art room. Once installation is complete, have the system balanced by a ventilation engineer.
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a High Efficiency Particulate Arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
6. Continue with plans to install new roof. Replace ceiling tiles and disinfect areas of water leaks as needed.
7. Repair leak beneath sink in classroom 106, remove items if moldy and disinfect area with a proper antimicrobial as needed.
8. Seal door to mechanical room in the special services area to prevent penetration of odors and/or drafts.
9. Store chemicals and cleaning products properly and out of the reach of students. Ensure all containers are properly labeled for identification in the event of an emergency.
10. Change or clean filters for window-mounted air conditioners to prevent the re-aerosolization of dirt, dust and particulate matter.
11. Clean chalkboards and chalktrays regularly to prevent the build-up of excessive chalk dust.

12. Inspect shrubbery along outside perimeter of building periodically; trim away from fresh air intakes as needed.

13. To avoid lingering odors from photocopier toner cartridges, seal in plastic bag after use and/or remove from building interior and dispose of in dumpster.

References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL.

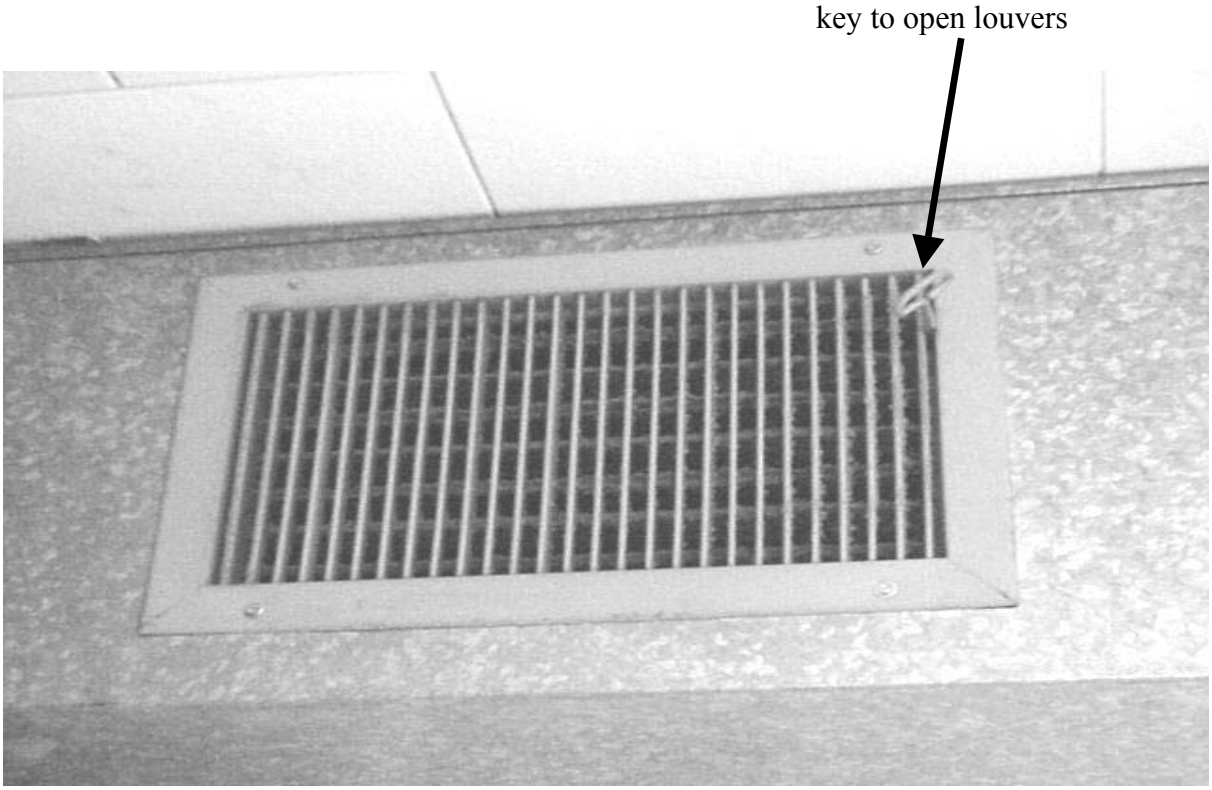
Diversified, 1998. East Bridgewater Public Schools: Dust Characterization Sampling Diversified Environmental Corp. Project No. 98-01.

MDPH. 1999. Indoor Air Quality Assessment Central Elementary School, East Bridgewater, MA. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

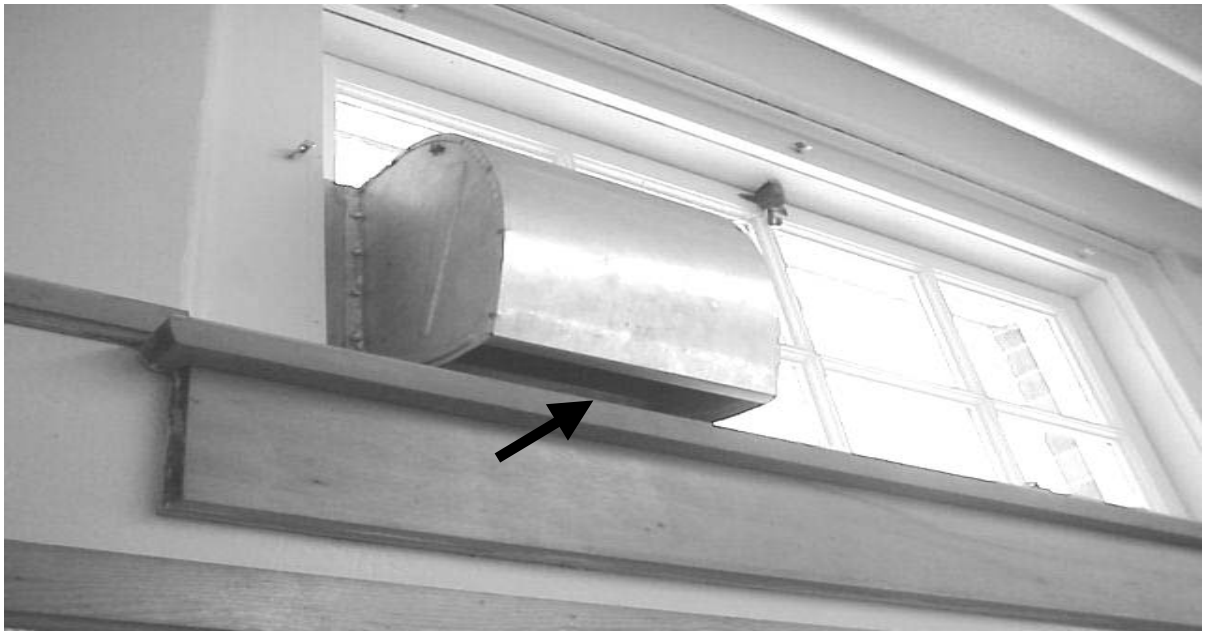
SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Picture 1



Vent in Special Services Area Noted with Louvers Closed
Note Key to open Louvers

Picture 2



Window-Mounted Exhaust Vent Located in Classroom 11
Note Windowsill Obstructing Vent Opening

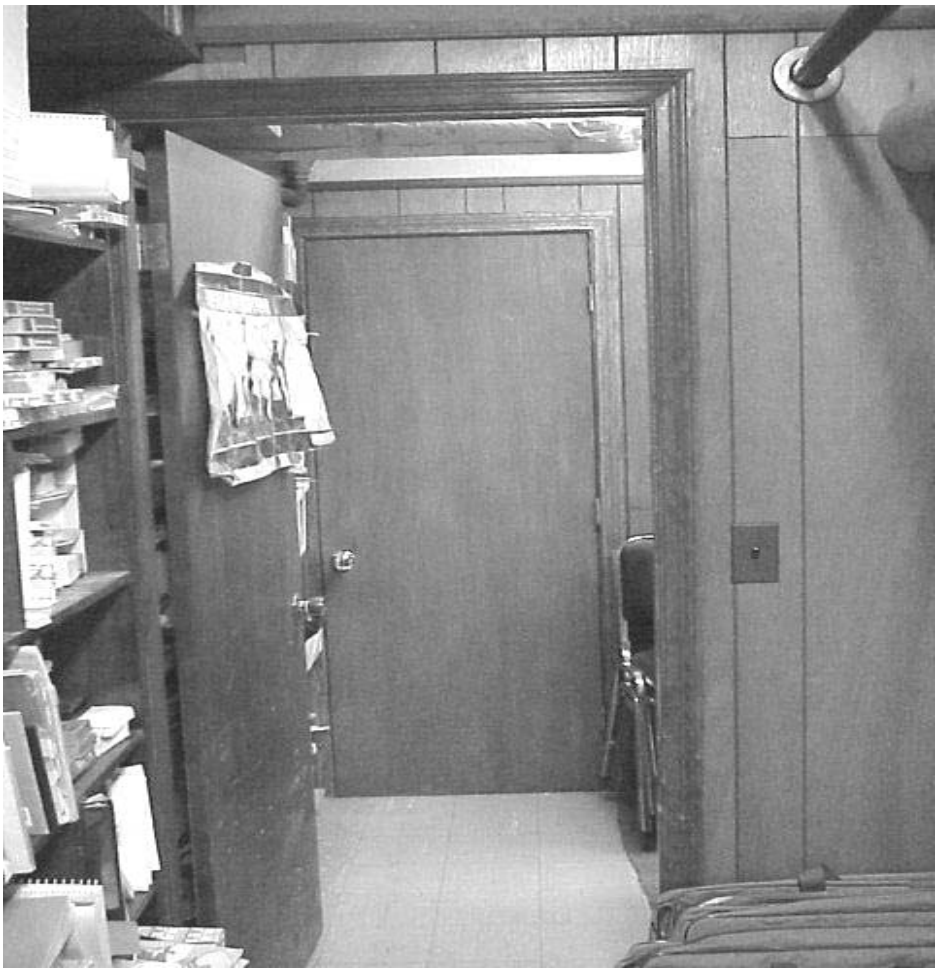
Picture 3

Large Cabinet in Cafeteria Obstructing Wall-Mounted Exhaust Vent

Picture 4

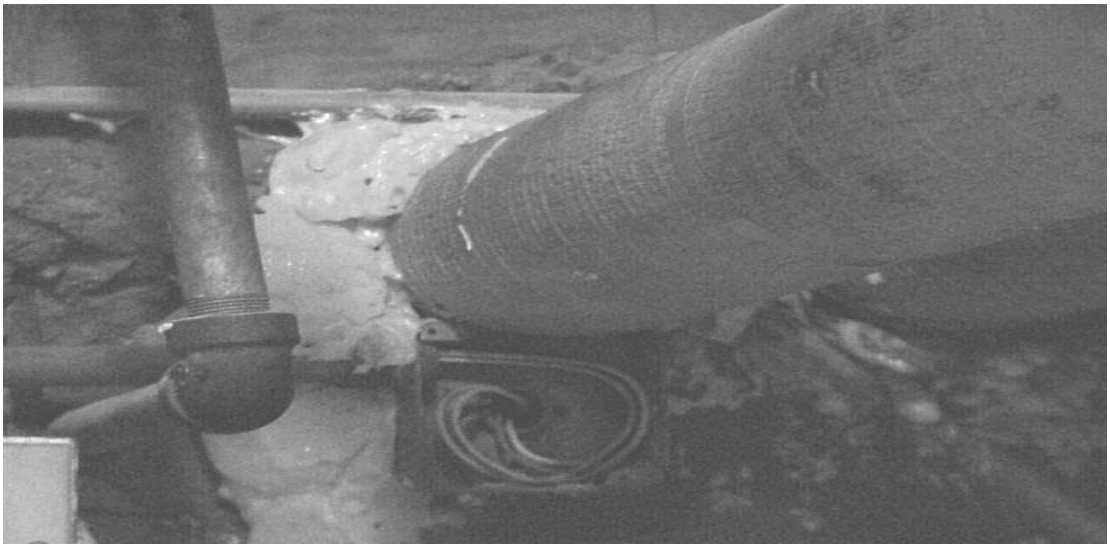
Dehumidifier Draining into Sink in Room 11

Picture 5



Door Installed to Mechanical Room in the Special Services Area

Picture 6



Utility Holes in Mechanical Room (Special Services Area)
Note Holes are Sealed with a Foam Material

Picture 7

Classroom Univent Note Classroom Divider Obstructing Airflow to/from Univent

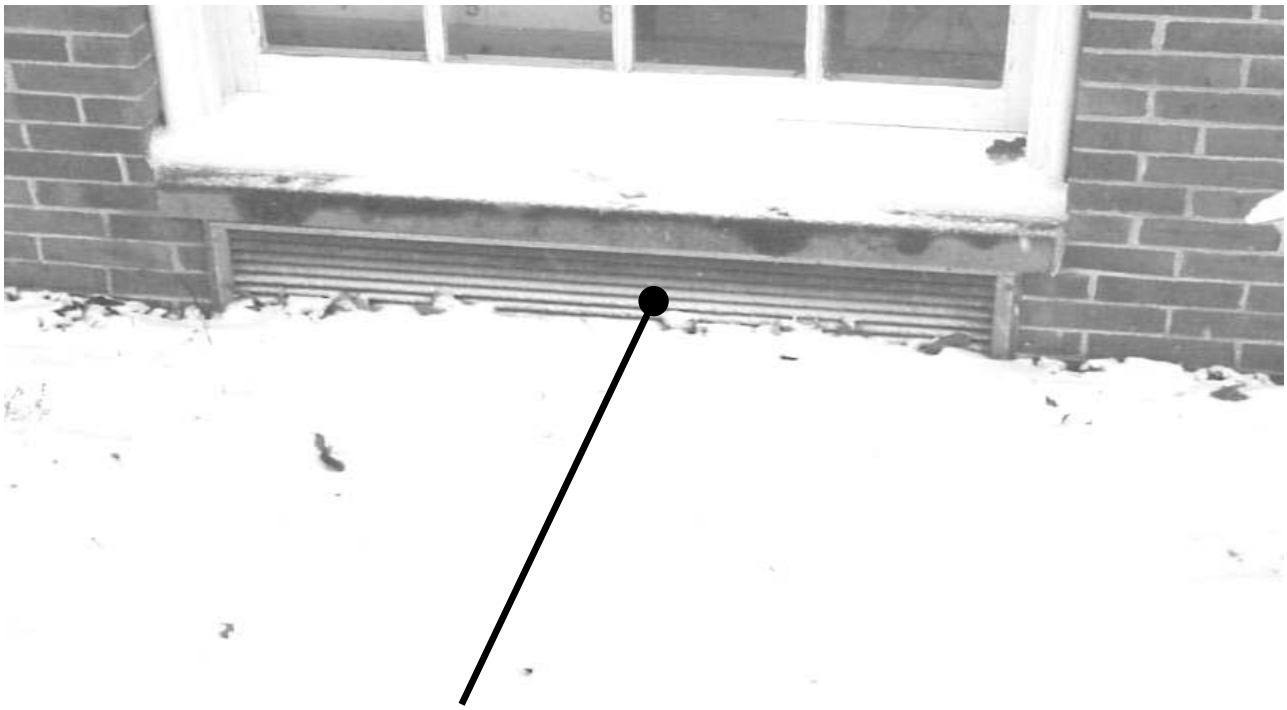
Picture 8

Classroom Exhaust Vent Obstructed by Table and Chair

Picture 9

Classroom Exhaust Vent Obstructed by Various Items

Picture 10



Univent Fresh Air Intake Partially Covered with Snow

TABLE 1

Indoor Air Test Results –Central Elementary School, East Bridgewater, MA – February 17, 2000

	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	429	27	17					weather conditions: clear, sunny, NE wind 10-15 mph
Guidance Office	880	72	12	2	no	no	yes	exhaust-weak
Restroom							yes	exhaust on-fine
Special Services	568	72	7	0	no	yes	yes	supply shut, exhaust off
Room 7	653	79	3	21	yes	yes	yes	
Room 210	1119	76	10	22	yes	no	no	dry erase board
3rd Floor Professional Development Room	1350	72	13	7	no	no	yes	door open
210 Office	1240	77	10	5	no	no	no	water cooler, vent blocked-behind refrigerator
Room 204	725	76	3	21	yes	yes	yes	window open
Room 208	940	76	8	18	yes	yes	yes	exhaust-weak, door open, cleaning products

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results –Central Elementary School, East Bridgewater, MA – February 17, 2000

	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 104	790	78	5	20	yes	yes	yes	exhaust vent behind door
Room 106	756	76	4	21	yes	yes	yes	cleaning product under sink, active pipe leak under sink
Center Room	700			~40	yes	yes	yes	5 univents-on
Teacher's Workroom	692	77	7	4	no	no	yes	laminator, 4 photocopiers
Room 8	605	76	2	19	yes	yes	yes	
Room 209	860	75	7	10	yes	yes	yes	door open
Room 207	773	78	7	20	yes	yes	yes	
Room 205	767	77	3	21	yes	yes	yes	door open
Room 105	883	79	5	24	yes	yes	yes	window and door open, cleaning product under sink
Room 109	743	73	32	23	yes	yes	yes	cleaning product under sink

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TABLE 3

Indoor Air Test Results –Central Elementary School, East Bridgewater, MA – February 17, 2000

	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 108	714	76	3	19	yes	yes	yes	door open, cleaning product under sink
Cafeteria	915	76	8	200+	yes	yes	yes	door open, 5 univents-on, exhaust blocked by cabinet
Room 112	1190	78	8	22	yes	yes	yes	exhaust blocked by desk/chair
Room 206	789	76	6	21	yes	yes	yes	door open, chalk dust, cleaning product under sink
Room 110	724	78	5	17	yes	yes	yes	
Room 111	794	77	5	17	yes	yes	yes	
Room 114	842	77	4	24	yes	yes	yes	
Room 113	787	75	3	26	yes	yes	yes	exhaust partially blocked by shelf
Room 13	893	76	7	20	yes	yes	yes	supply off-activated by maintenance staff
Room 115	890	77	5	~18	yes	yes	yes	

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Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results –Central Elementary School, East Bridgewater, MA – February 17, 2000

	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 9	595	70	29	19	yes	yes	yes	door and window open
Library	742	79	3	22	yes	yes	yes	6 plants
Room 5	716	78	2	20	yes	yes	yes	
Room 6	650	76	3	3	yes	yes	yes	21 occupants gone ~15 min.
Art Room	820	71	9	19	no	no	no	2 doors open
Room 11	776	76	27	23	yes	yes	yes	window mounted exhaust vent, cleaning product under sink
Room 14	770	74	5	23	yes	yes	yes	cleaning product
Room 12	820	76	4	21	yes	yes	yes	univent return blocked by bookcase

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